

RISE OF BIO-BASED CHEMICALS: HYPE OR GAME-CHANGER?



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The latest BioE3 policy builds the framework for high-performance biomanufacturing to propel the development and production

With a global market size of over US \$73 billion and a CAGR of 9.6% between 2024 and 2032, the popularity of bio-based chemicals is expected to increase further

The global and Indian bio-based chemicals market has enormous growth potential driven by a multitude of factors. The production of such chemicals depends on the availability of feedstock, and it is incumbent upon the stakeholders to manage all such components and ensure smooth processes to transition in a sustainable future.

COP 29 saw crucial strides in advancing climate action for developing countries but significant gaps remain. Issues like the scale of financing, the integrity of carbon markets, and concrete support for adaptation efforts require urgent attention and more decisive action. With Brazil hosting

COP 30 this year, there is a critical opportunity to translate commitments into impactful solutions. As COP 30 approaches, the world will be watching to see whether this vital decade for climate action can deliver the results needed to protect the most vulnerable and secure a sustainable future for all.

The accelerated transformation towards a net zero circular economy is only feasible with a joint holistic approach to value chain collaboration. It

became clear that alternative feedstocks, such as bio-based, CO₂-based and recycled feedstocks, are the key levers to enable this transformation.

The rise of bio-based chemicals is a game changer, and we do not have any other choice. We see slower growth towards adoption, but it is happening. We can adopt cleaner energy and recycling, but net zero will not be possible without de-fossilization. An integrated biorefinery is a step towards achieving this goal.

Defining Bio-based Chemicals

Such chemicals are usually produced through fermentation, enzymatic processes, chemical conversion, or biomass. They can be crops (including sugarcane, corn, and soybeans), wood chips, lignin, algae, microbes, and organic waste.

Current State of the Market

With a global market size of over US \$73 billion and a CAGR of 9.6% between 2024 and 2032, the popularity of



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bio-based chemicals is expected to increase further. Volatility in petrol and diesel prices, consumer preferences shifting to sustainable products, and depleting stock of non-renewables have fuelled the interest in these products. From the Indian perspective, the sector is also witnessing steady and robust growth with a strong CAGR and growth estimates.

Bio-based Chemicals and Biofuels

In the global economy, biotechnology has begun taking on a significant role. Bio-based chemicals and biofuels are connected through their shared feedstock use, standard processing techniques, and circular economy potential. However, the essential linkage is the role of integrated biorefineries in this process. For a biorefinery, it is necessary to be economical and to produce products at a price that customers would be keen to buy, which is the biggest challenge in the real world.

Each serves a different angle regarding ensuring sustainability across the value chain. Renewable fuels produce drastically less pollution compared to fossil fuels. At the same time, products developed from biochemicals help manage the waste generated from the process, help de-fossilization, and channel it into something productive.



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Integrated Biorefinery Concept for Tomorrow

Integrated biorefinery processes are efficient for producing bio-based products and secondary energy carriers such as fuel, power, and heat, along with oil refineries. The pilot projects in India indicate that both conventional (biodiesel and ethanol) and advanced biofuels (of lignocellulosic origin) are yet to be produced profitably to create a sustainable market without implementing government policies and subsidies.

The integrated biorefinery concept enables the conversion of waste to high-value streams in economically attractive pathways by focusing on the key aspects: availability, affordability, sustainability, and productivity. As the world is going towards net zero, there should be a general (global) accepted policy of biogenic CO₂ uptake calculation of different biomass crops. So, a biorefinery approach applied to different biomass crops will be more valued within climate policy.

Policies Pushing the Agenda

The Indian government, in a bid to accelerate the integrated bio-refinery agenda, has begun the Mission Integrated Bio-refineries Policy to also

design innovative solutions in the sector. Ongoing bio-based innovations with enzymes would only foster and bolster these growth estimates.

In August 2024, the government launched the BioE3 Policy, which aims to channel the trickle-down impact of biotechnology on the economy, environment, and employment. This policy builds the framework for high-performance biomanufacturing, which will propel the development and production at the scale of bioproducts within the nation. With the nation's vast agricultural resources and burgeoning demand for fuel appropriately implemented, such a policy shift could radically change the economy.

The focus must be on strategies to manage the most potential source, i.e., agricultural residues. Some critical issues remain: deployment of existing technologies in agriculture, better agronomic and breeding technologies, proper supply chain, adequate policy framework, effective financing mechanism, and practical information dissemination. However, a policy like BioE3 could be instrumental in sparking sectors to tackle such obstacles.

Biofuels in India are crucial as they align with government initiatives such as Make in India, Swachh Bharat Abhiyan, Self-Reliant India, and skill development. They also offer opportunities to reduce imports, increase farmers' incomes, transform waste into wealth, and create employment.



Circular Economy and Biorefineries

In a broad future circular economy, biomass-originated chemicals will play a critical role. The products and processes to generate them from such materials are usually safe by design. Biorefinery systems will be vital to greater recycling and chemical and polymer production. To ensure a continuous fuel supply and to supplant the huge demand for emerging economies, economies have to be sustainable and circular - on one hand, manufacturing bio-based chemicals that have a wider use in products and bio-fuels that can reduce the dependency on fossil fuels. With both ranges of products, there can be a strong validation of the importance of bio-based products, possibly leading to production at scale.

Challenges Hindering Growth

Despite a promising scenario, there are some pertinent challenges that the industry needs to come together.

Feedstock Cost: Sugarcane molasses and other bio-based feedstocks compete with food production for

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land and resources. For countries with large populations like India, there are concerns that if the transition is rapid and sudden to bio-based feedstock cultivation, it could lead to price rise and adversely impact food security. Storing and transporting diverse feedstocks like cellulosic biomass could require substantial development and investment. In such cases, ensuring sustainable sourcing and proper resource utilization could be critical in elevating production and minimizing environmental impact.


Technology Constraints: Bio-based

chemical manufacturers need to scale up rapidly to scale up rapidly and maintain cost-effectiveness. One way to do that would be through innovation and rapid advances. For production, efficient and affordable downstream processing is vital.

Management Issues: Transitioning to a bio-based future would require a skilled workforce with biotechnological experience. Proper waste management efforts are also essential in shoring up efficiencies in the bio-based production chain. These objectives would require close collaboration with multiple external stakeholders, government agencies, leading tech institutes, and private enterprises.

The Future of Chemicals is Green

Looking at the current state of affairs and the rise of biobased chemicals in the short term may seem like hype, but it is a game changer in the mid and long term. Countries and companies are sticking to their net zero and decarbonization goals. The global energy mix is observing a rapid transition to renewable fuels. While in its early stages, the market for bio-based chemicals in India shows genuine promise. Key stakeholders must come together to develop innovative alternatives that are marketable to the general public.

The sector needs better long-term planning and policies and technological solutions that are practical and effective in an actual life scenario. Lastly, while aim and vision should be high, the same can be done by taking small but concrete steps. It allows the ecosystem to grow while ensuring the penetration of fuel and technologies .



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